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(54) **STRAPPING MACHINE WITH STRAPPING HEAD SENSOR**

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Related U.S. Application Data

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(52) **U.S. Cl.** **100/4**; 100/29; 100/32; 53/64; 226/11

(58) **Field of Search** .... 100/4, 26, 29, 100/32, 32 PB; 53/589, 64; 156/494; 242/563; 226/11, 45; 200/61.13, 61.18

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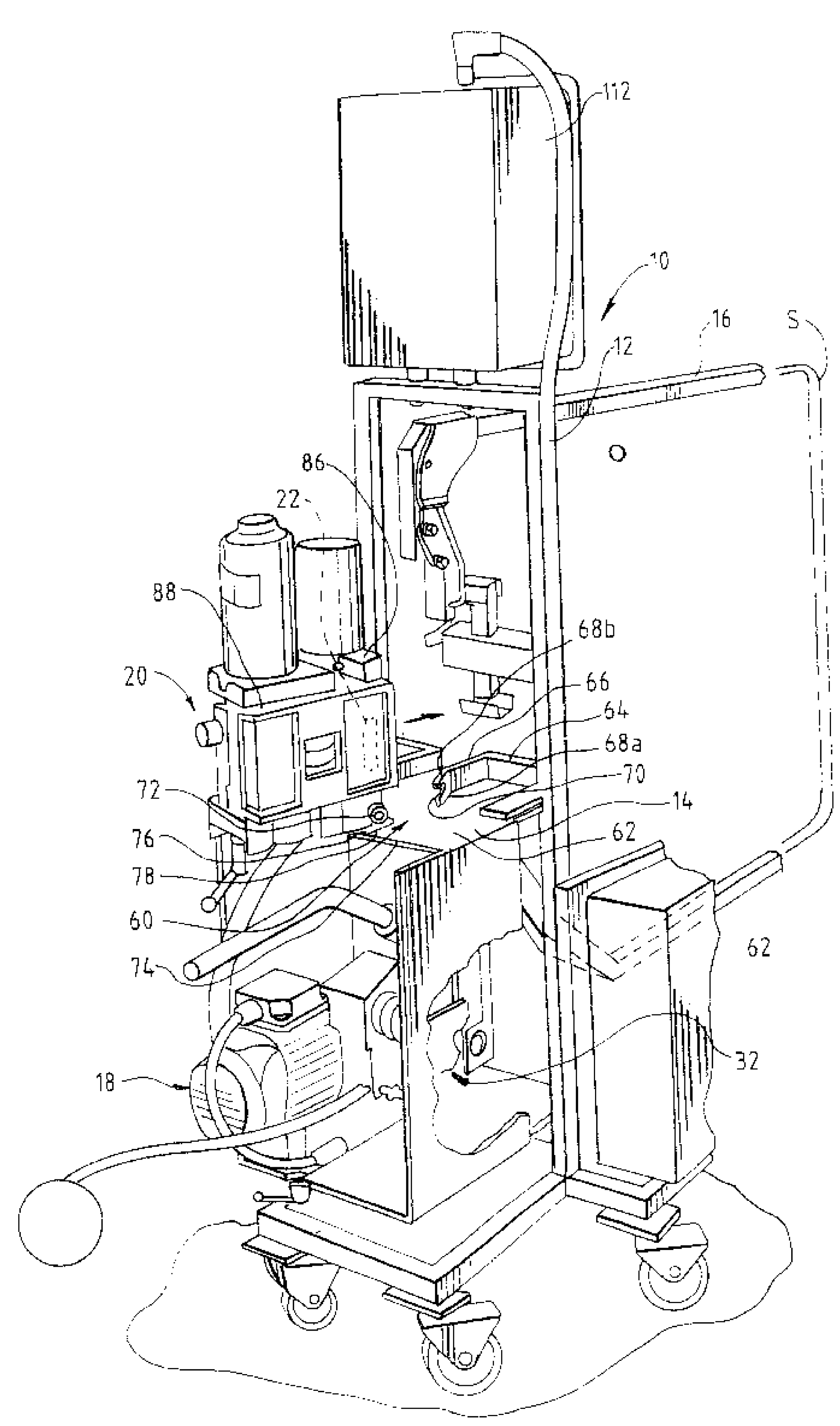
(57) **ABSTRACT**

A strapping machine for positioning a strapping material around an associated load and sealing the strapping material to itself around the load includes a frame, a chute defining a strap path that is mounted to the frame, and a feed assembly mounted to the frame. The feed assembly is configured to operate in a feed mode to feed the strapping material and to operate in a take-up mode to retract the strapping material. A strapping head is configured to seal the strapping material to itself. A controller is operably connected to the feed assembly and controls the operation of the strapping machine. A sensor is disposed to sense the presence and absence of strapping material at the strapping head. The sensor includes first and second movable biased elements cooperating with one another and movable between a first position in which the sensor senses the presence of strapping material and a second position in which the sensor senses the absence of strapping material. The sensor is operably connected to the controller such that the sensor senses the absence of strapping material at the strapping head and generates a signal to initiate operation of the feed assembly in a refeed mode.

14 Claims, 7 Drawing Sheets



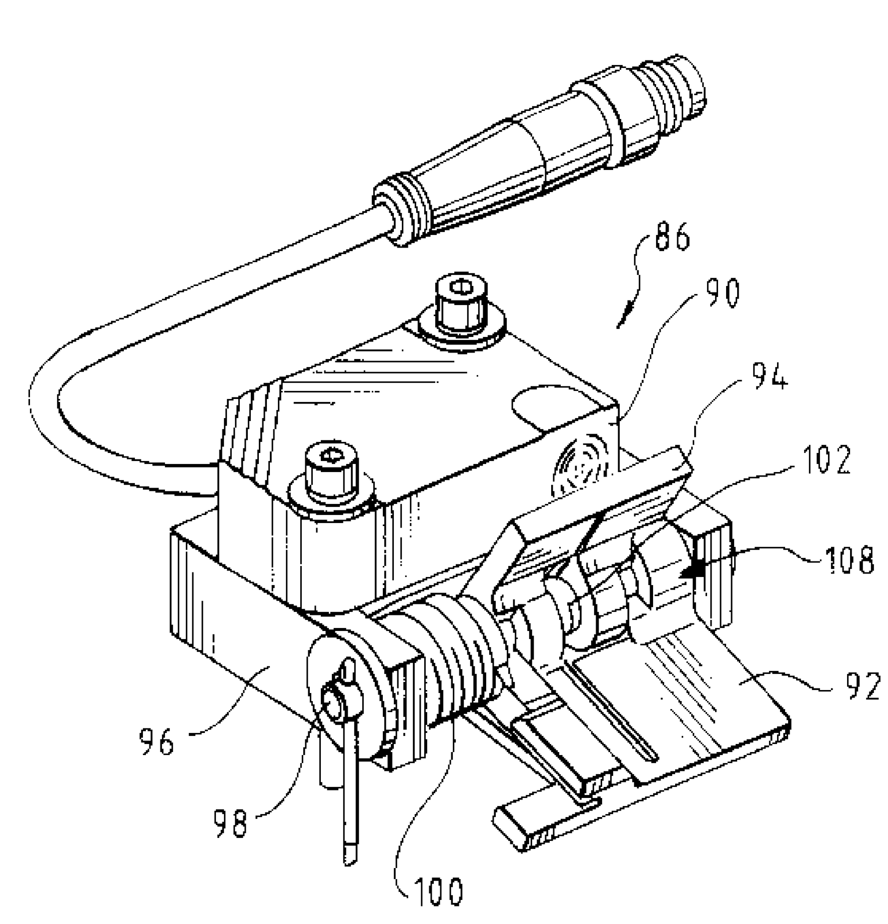


FIG. 2

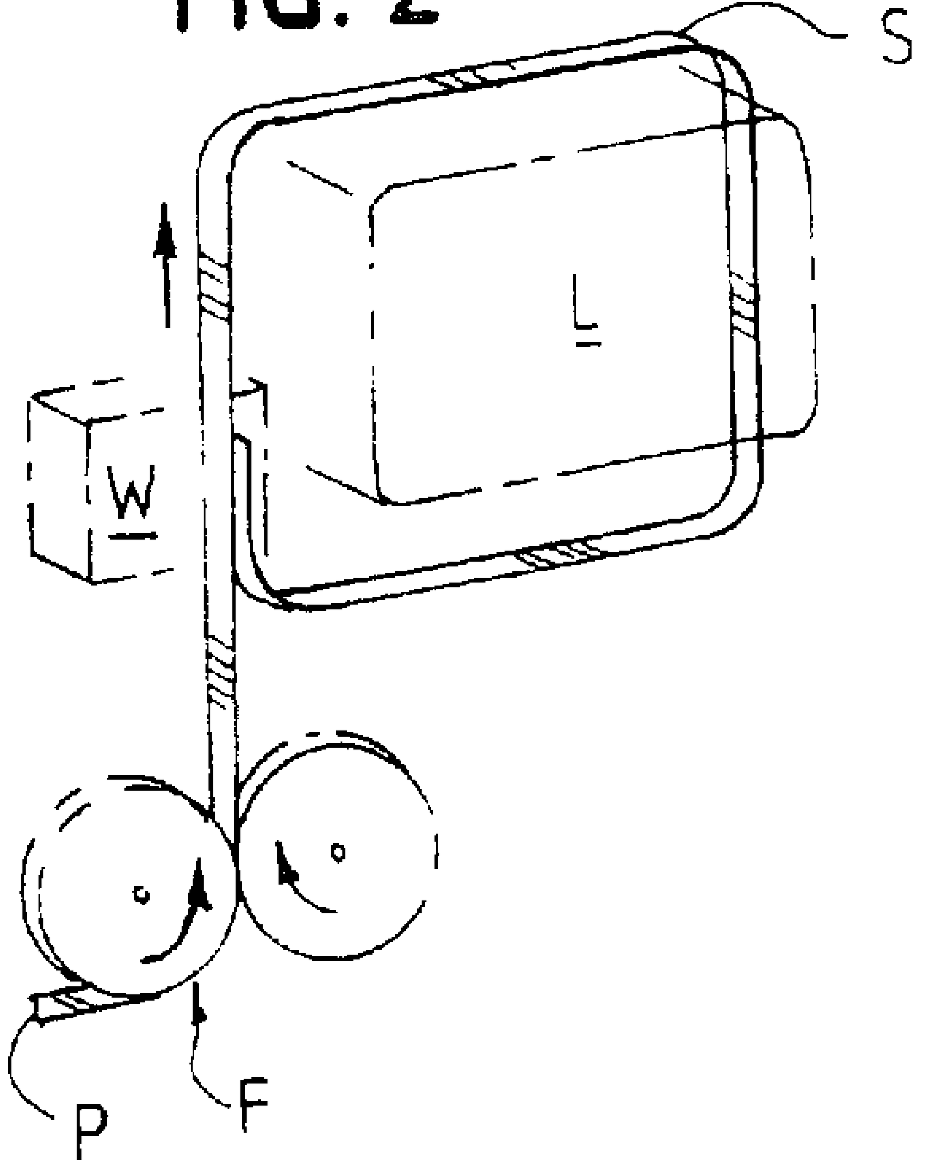

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FIG. 1

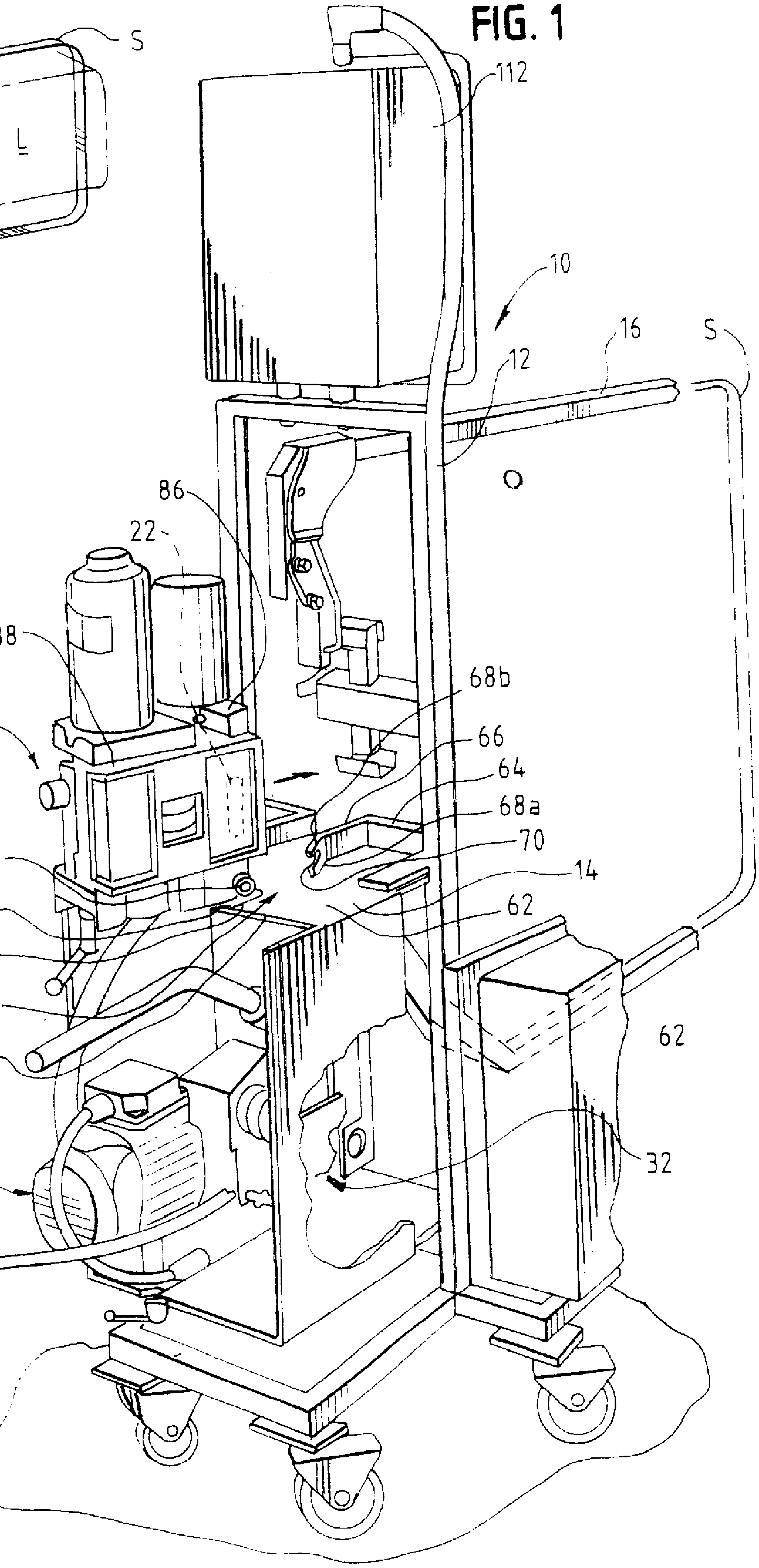
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FIG. 3

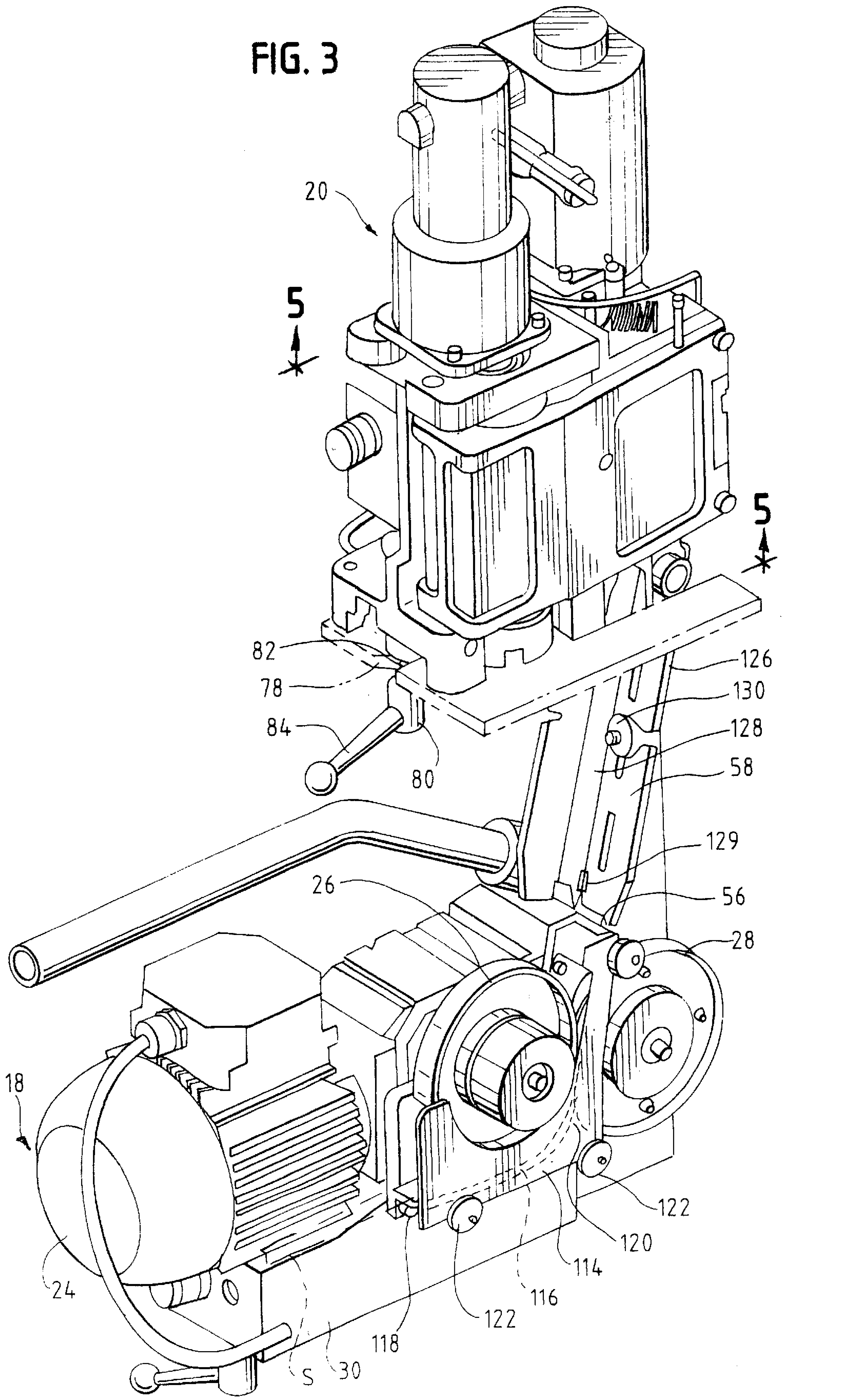
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FIG. 4

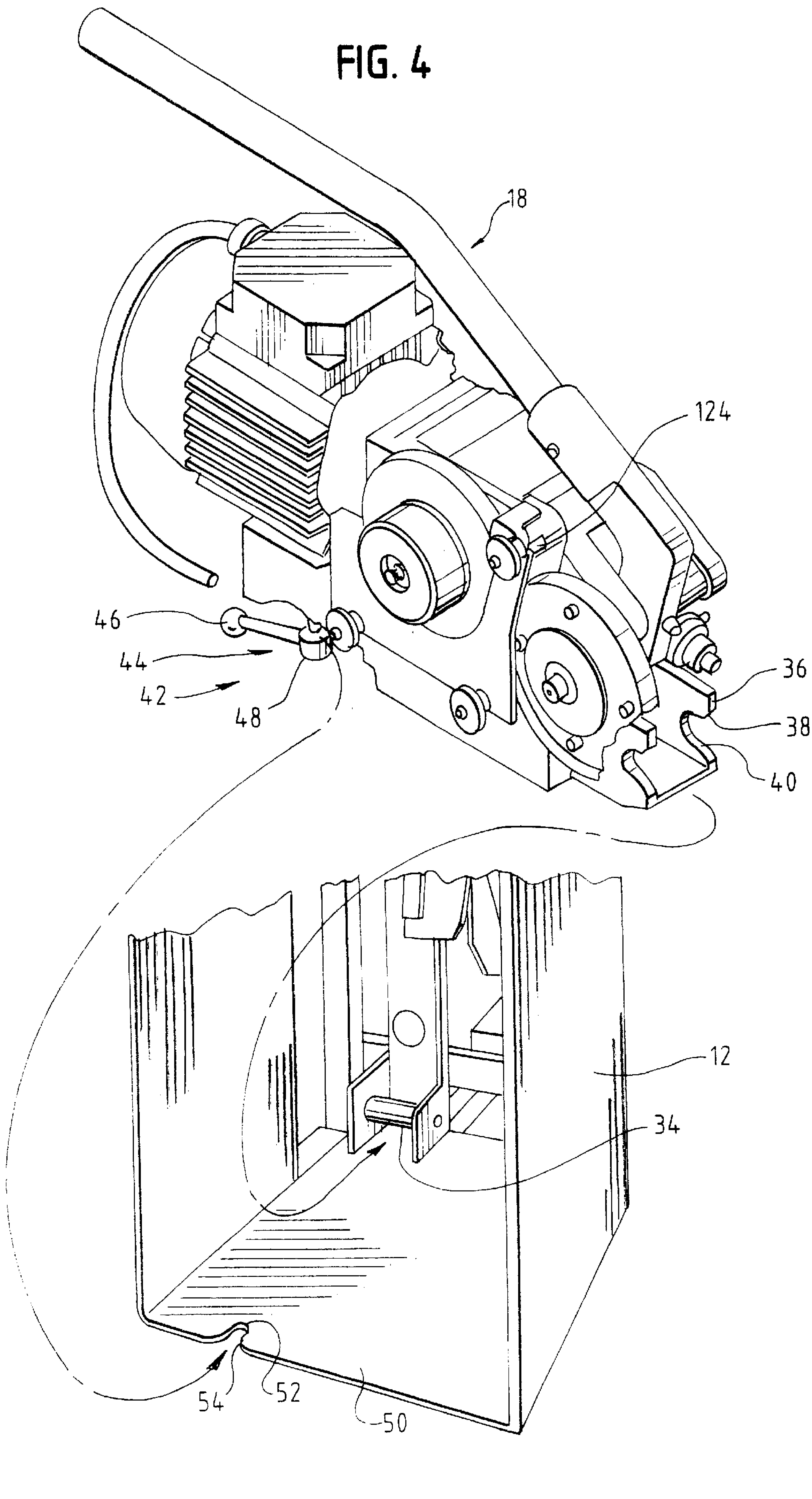


FIG. 5

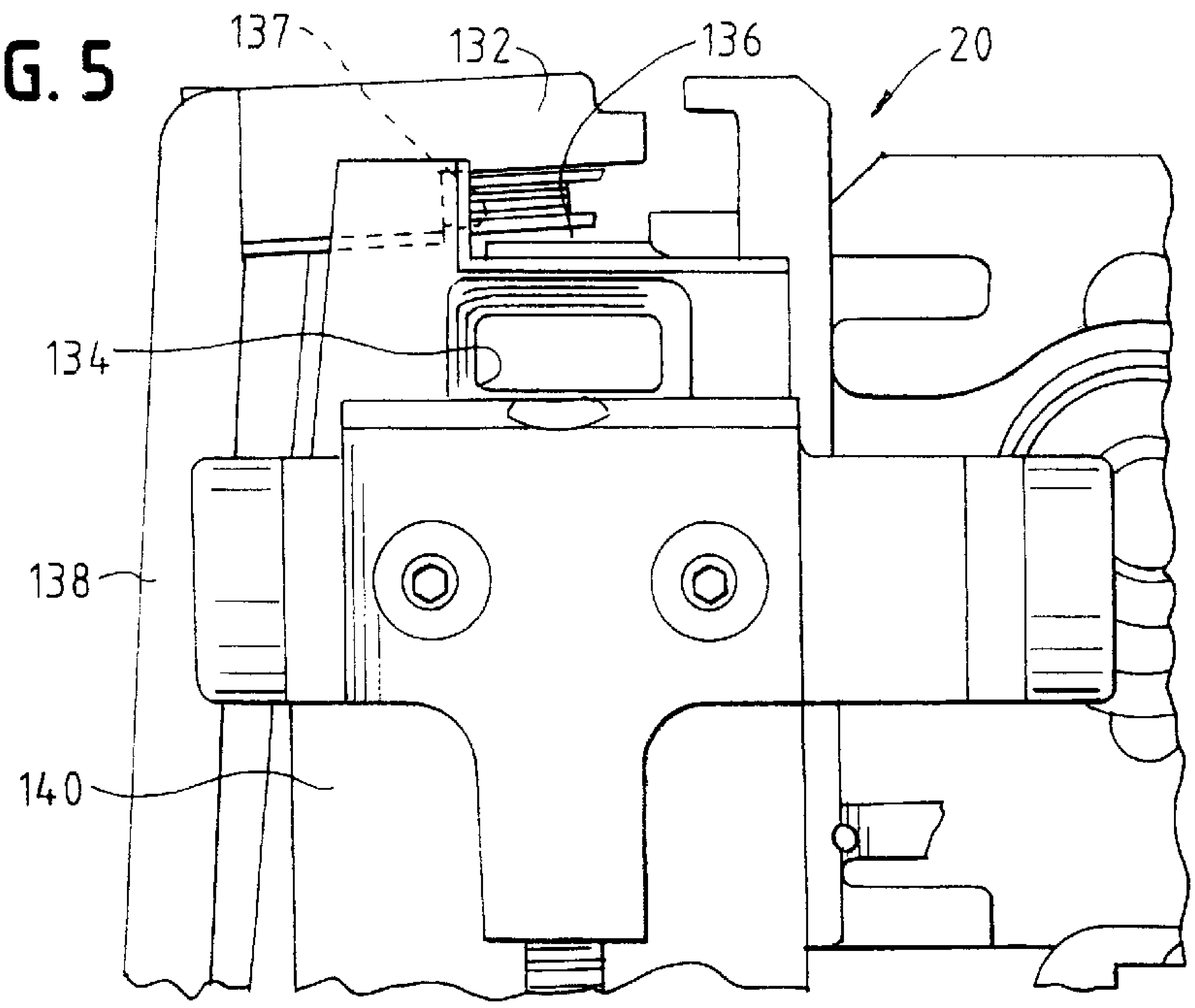


FIG. 6

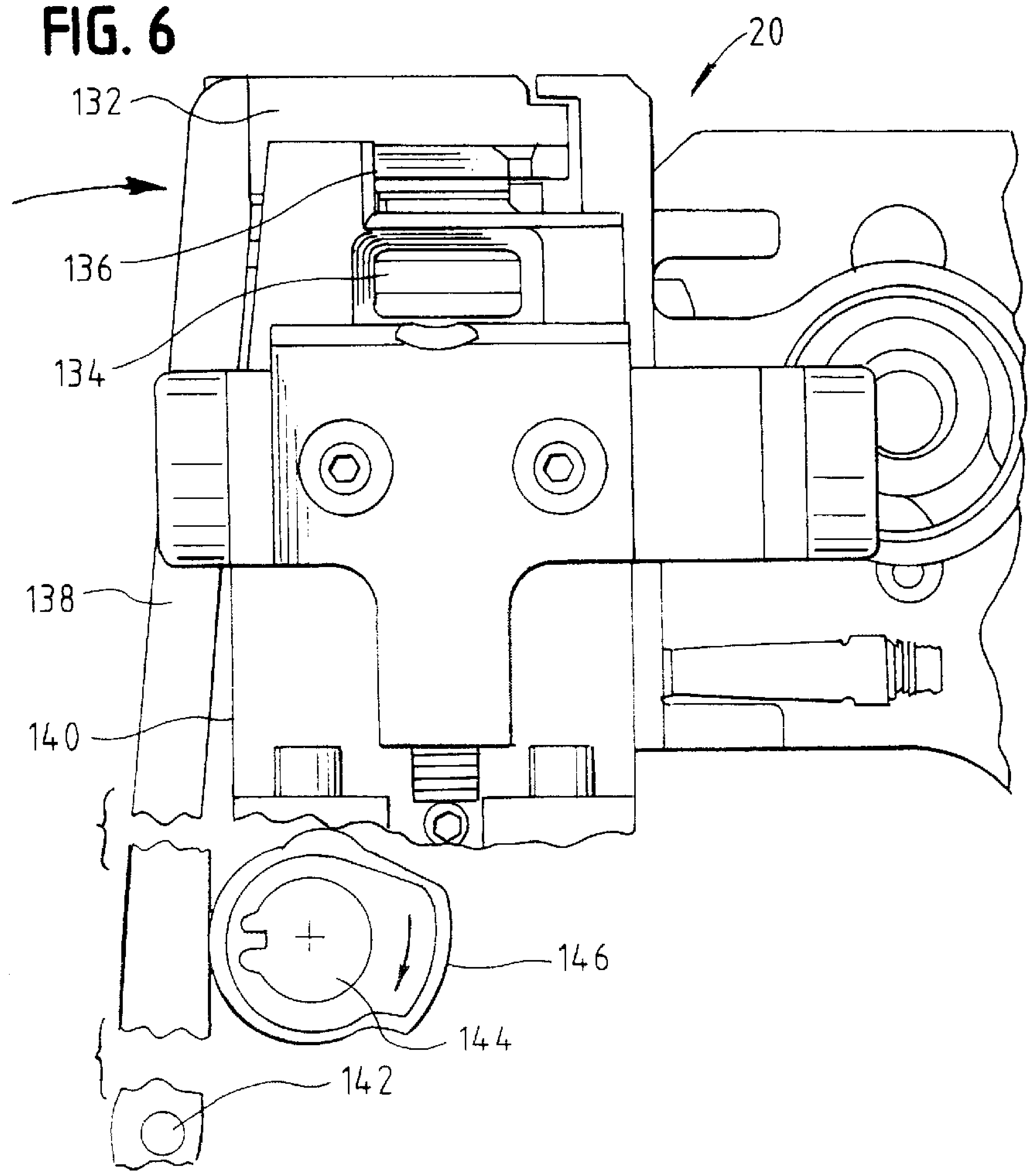


FIG. 7

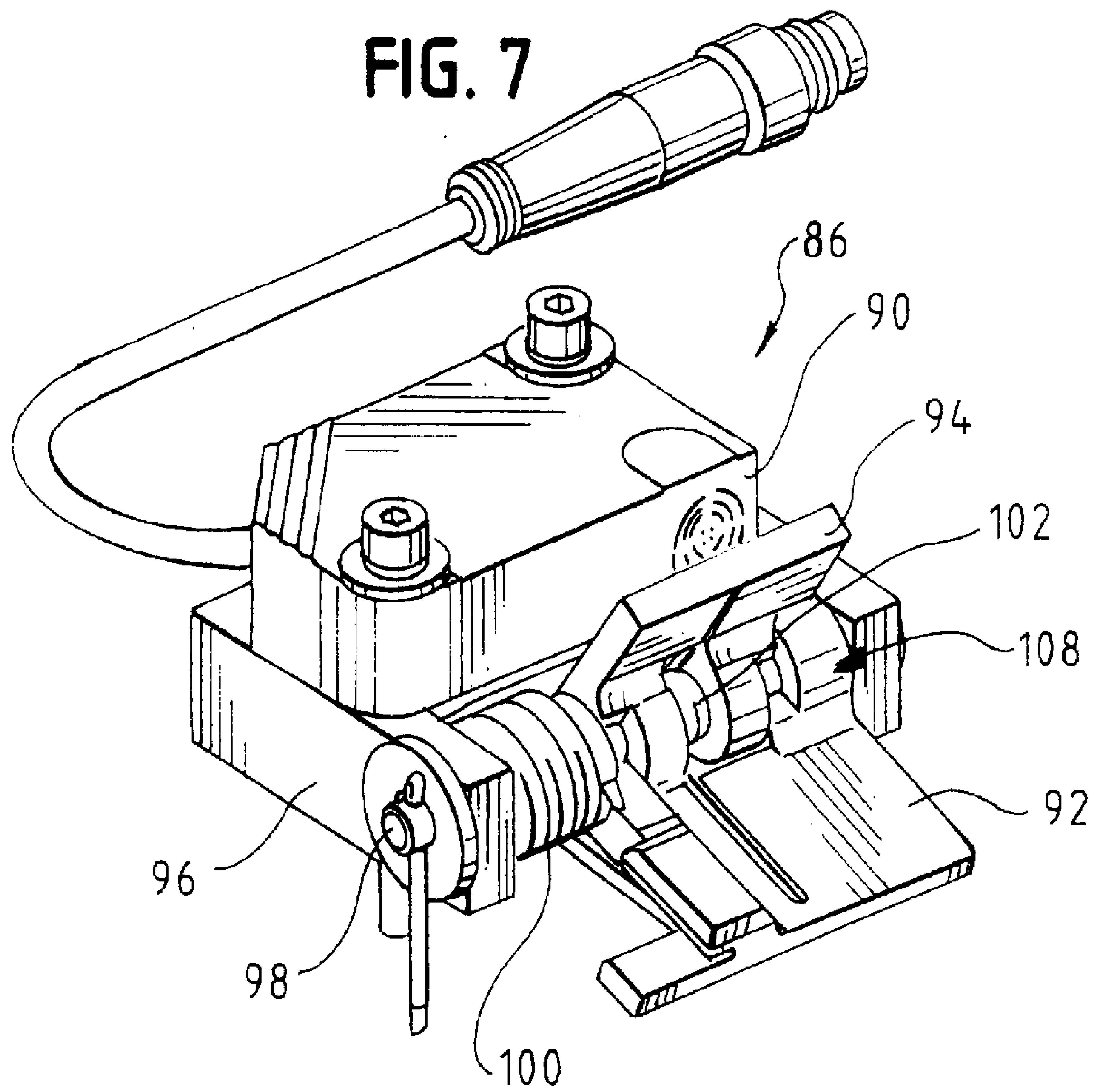


FIG. 8

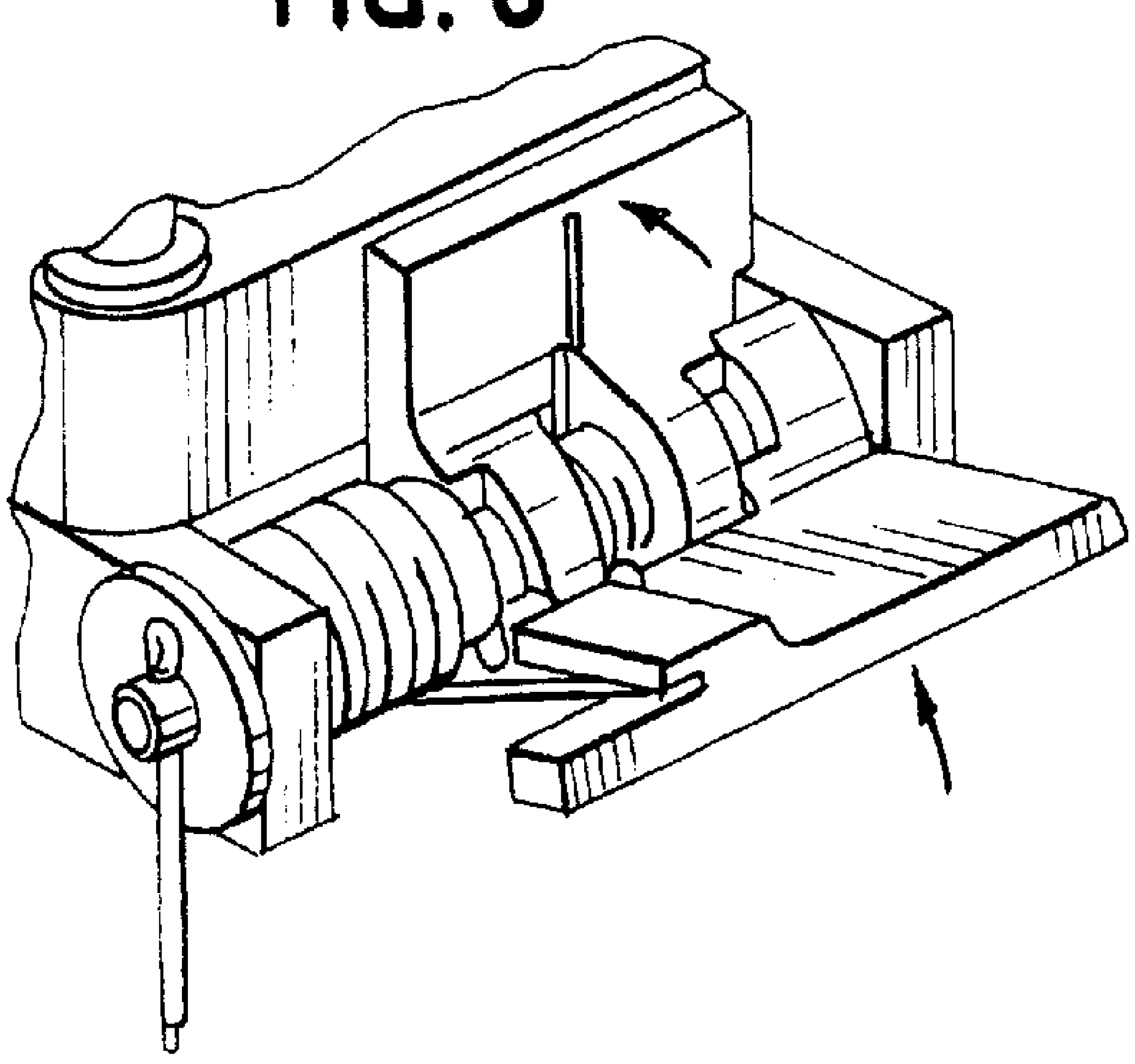


FIG. 9

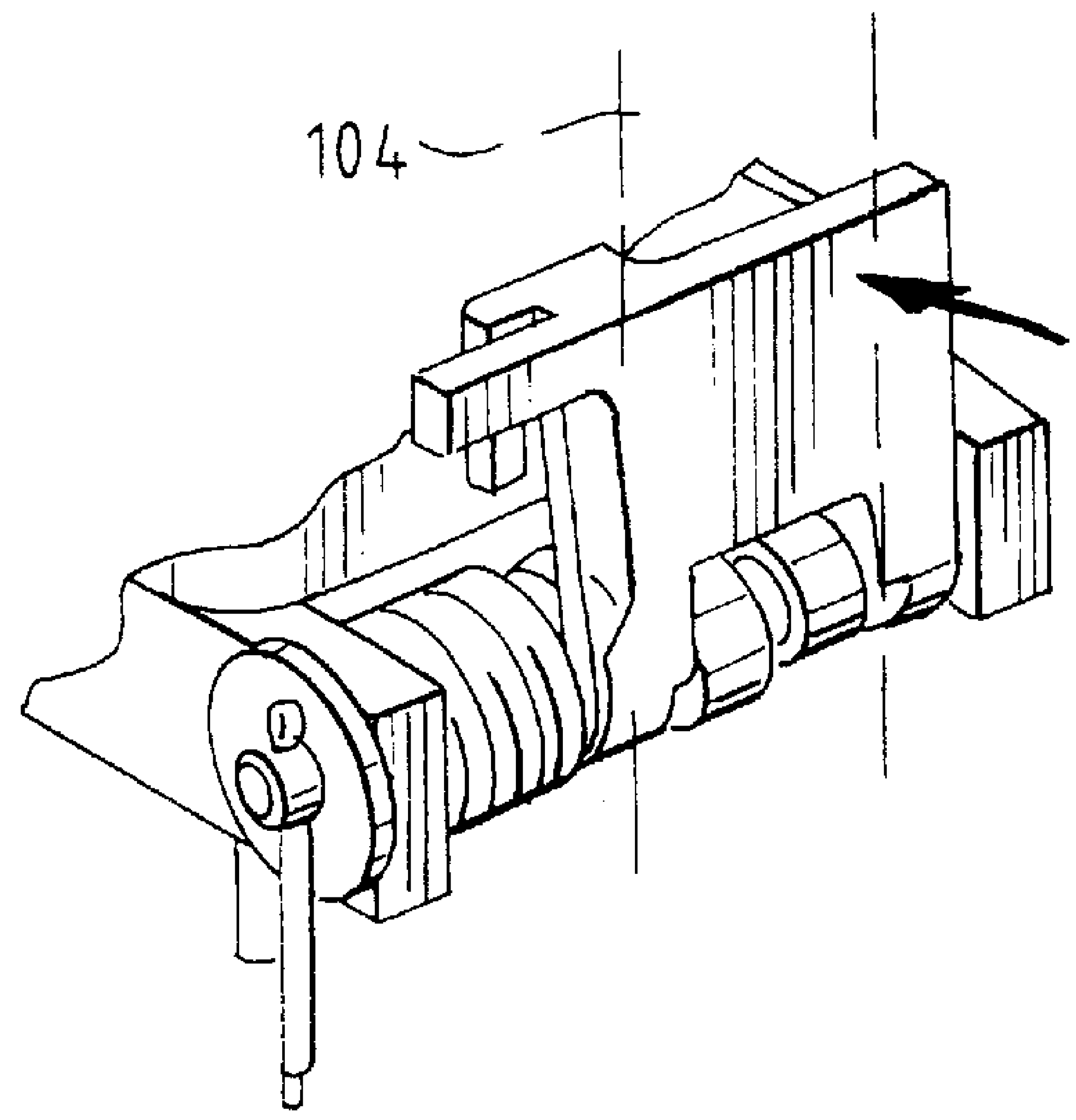


FIG. 10

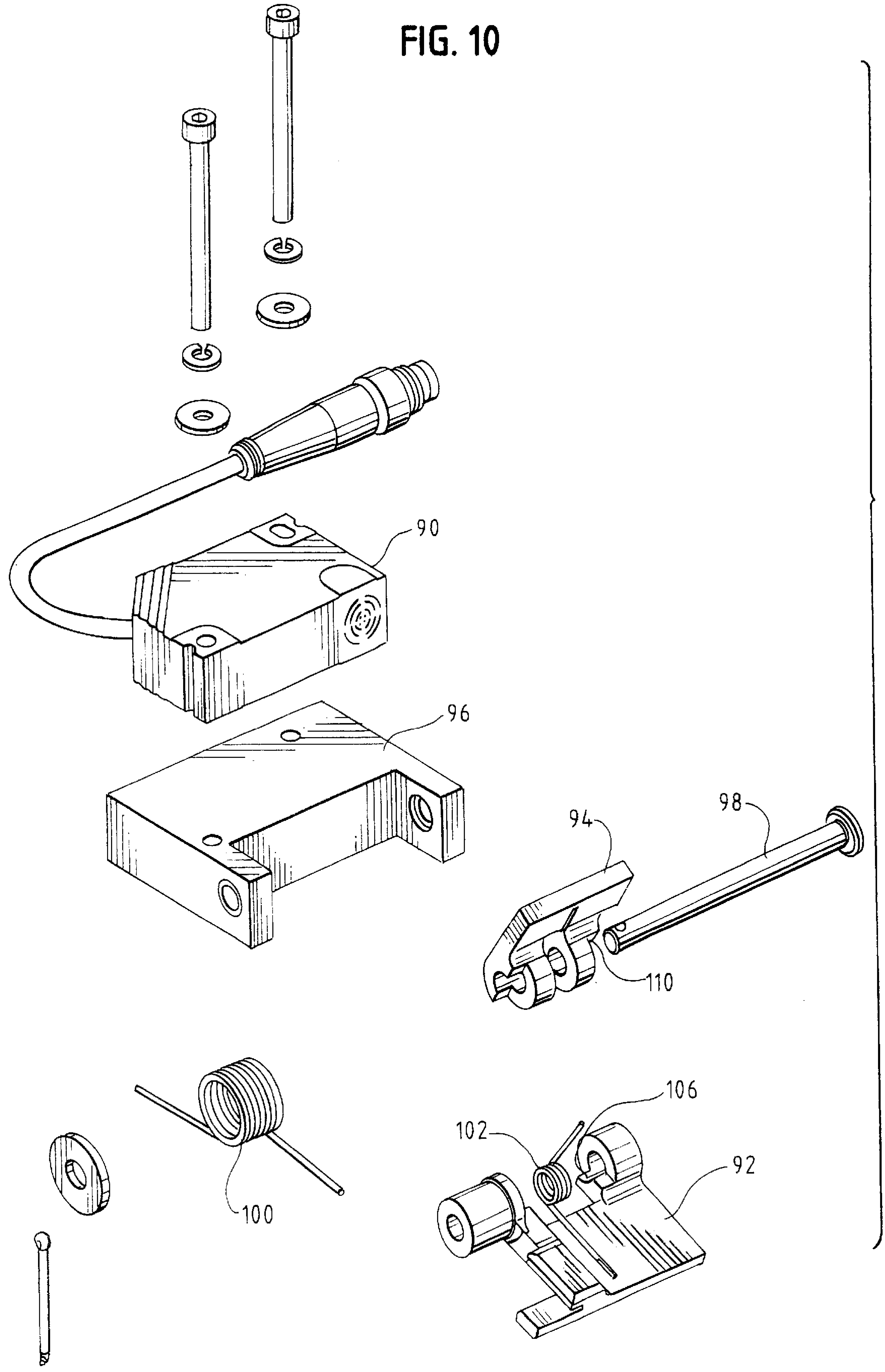


FIG. 11

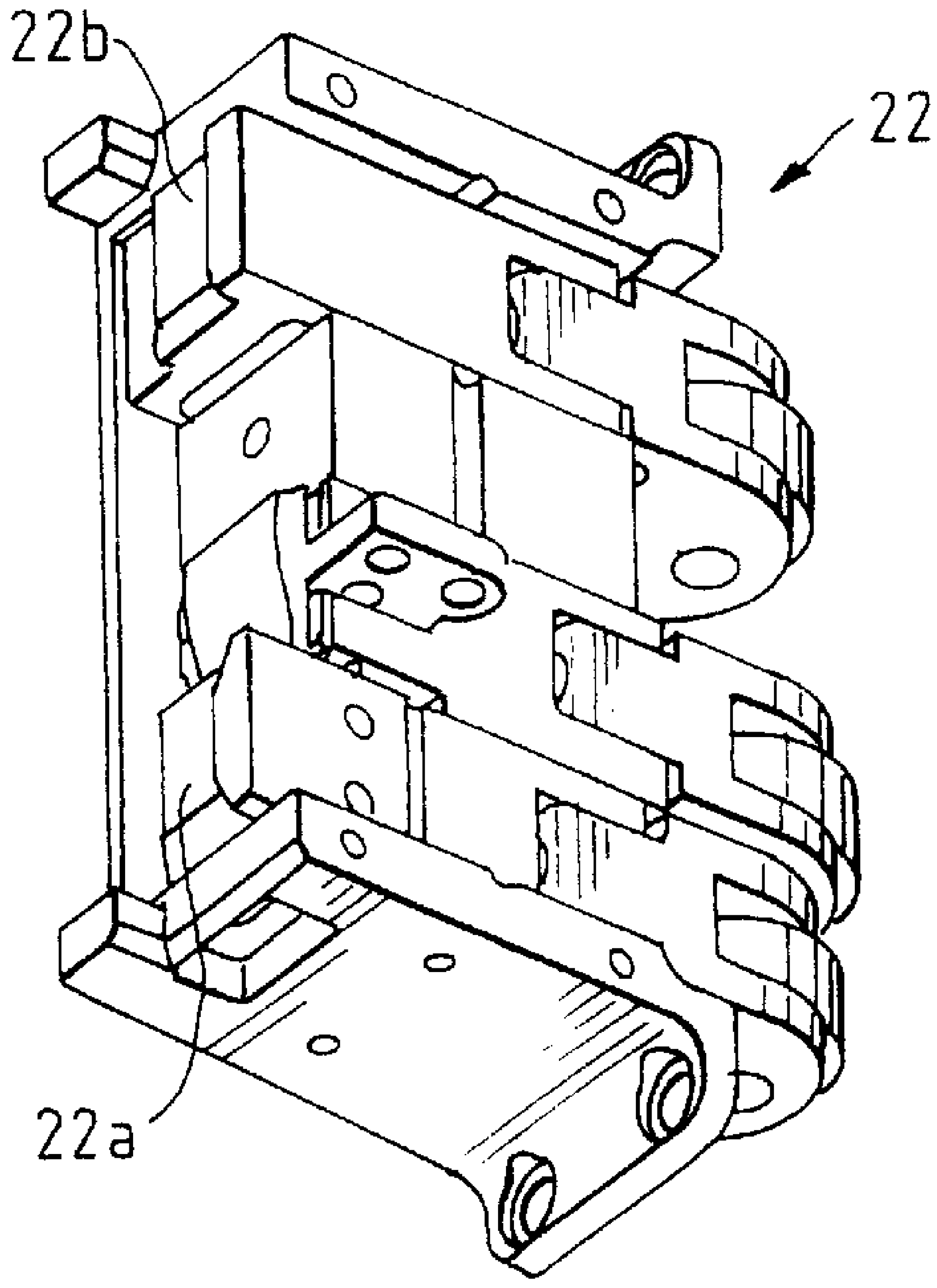


FIG. 12

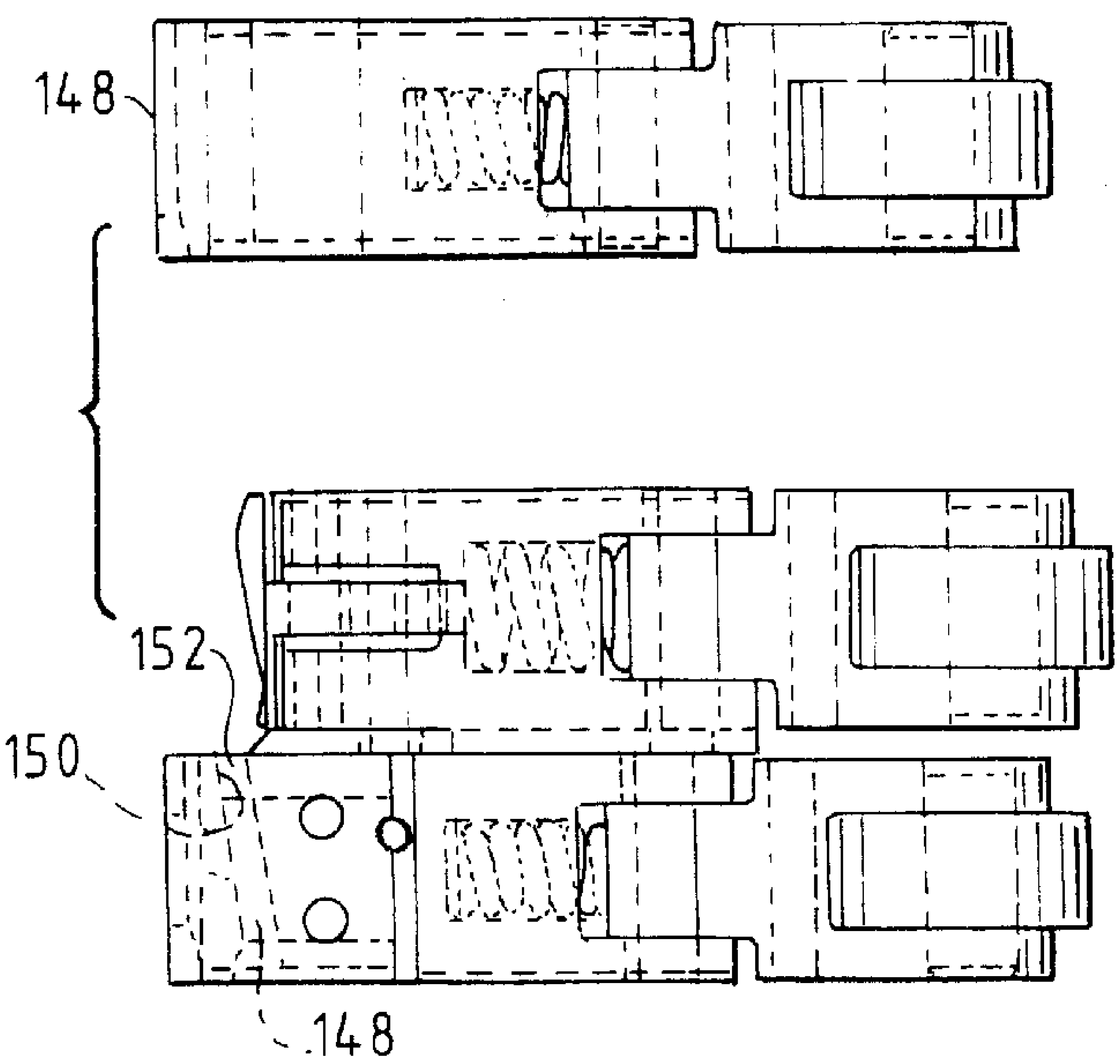
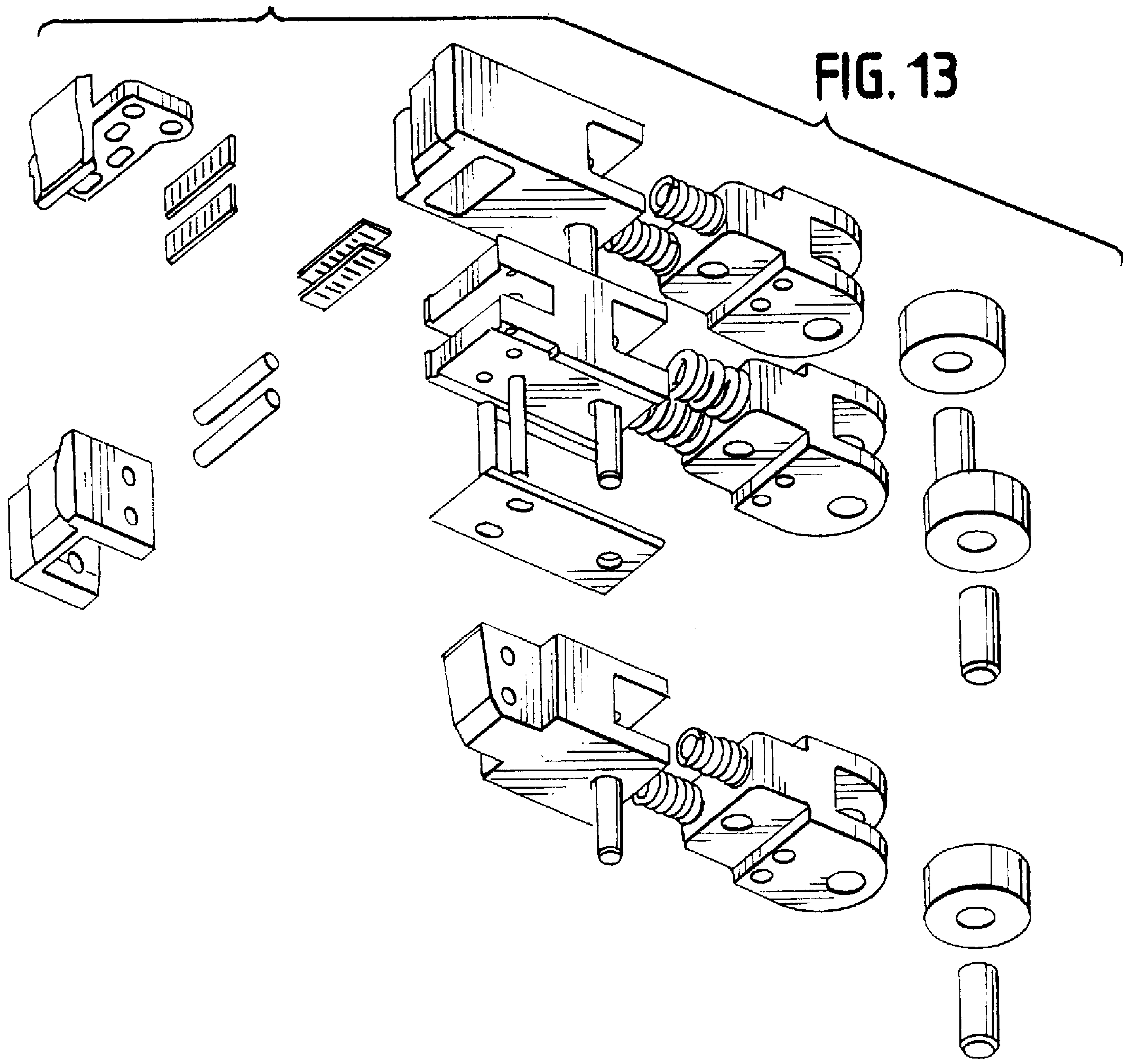


FIG. 13



STRAPPING MACHINE WITH STRAPPING HEAD SENSOR

BACKGROUND OF THE INVENTION

Strapping machines are in widespread use for securing straps around loads. There are two principle types of strappers. One type is a manually operated hand tool that can be used, for example, around a job site. Another type of strapper is a stationary arrangement in which the strapper is fabricated as part of an overall apparatus. In such a strapper, the strapping head and drive mechanisms are typically mounted within a frame. A chute is likewise mounted to the frame, through which the strapping material is fed.

In a typical, stationary strapper, the strapping head is mounted at about a work surface, and the chute is positioned above the work surface and above the strapping head. Strap material is fed to the strapping head by a set of feed and take-up wheels. The strapping material is fed, by the feed wheels past the strapping head, around the chute and back to the strapping head. The free end of the strapping material is then grasped, such as by a first part of a gripping arrangement. The strap is then retracted by the take-up wheels and tensioned around the load. The tensioned strap is then gripped by a second part of the gripping arrangement. A cutter in the strapping head then cuts the tensioned strap (from the source or supply) and the strapping head forms a seal in the strapping material, sealing the strapping material to itself around the bundled load.

Strapping operations are typically secondary operations in that these operations are used for bundling or securing individual items into a single, large load. The straps themselves are not of commercial concern to the end user; rather, it is the bundled items that are of concern. As such, it is important to be able to strap and move the items quickly and in a cost effective manner.

To this end, improvements have been made to strapping machines. One such improvement includes an auto re-feed arrangement, such as that disclosed in Bell, et al., U.S. Pat. No. 5,640,899, commonly assigned herewith. In such an arrangement, in the event of a misfeed of strapping material, the misfed strap is cut and ejected from the machine. Fresh strapping material is then automatically re-fed by the feed wheels through the strapping head and around the load. It has been found that such an arrangement saves considerable time and labor vis-à-vis removing the misfed or snapped strap and refeeding strap material into the strapper.

One drawback to the known re-feed arrangements is that they require separate feed and take-up wheels. That is, a pair of wheels (generally one driven and one idle) is required to feed the strapping material through the strapping head and the chute. A second, separate set of wheels (again, one driven and one idle) is required to take-up or retract the strap in order to tension the strap around the load. While these automatic re-feed arrangements have been found to save considerable time and labor, the requisite two pairs of wheels introduce additional maintenance concerns as well as timing arrangements with respect to the overall operation of the machine.

It has also been found that typically, these stationary types of strappers are designed and constructed such that the feed and take-up mechanism is located near to the strapping head. Because of the proximity of the feed and take-up arrangement to the strapping head, two sets of feed and take-up wheels are required in order to meet the overall operating requirements, given the physical constraints of the equipment.

Present designs of stationary strappers, which include a closely located feed and take-up mechanism to the strapping head, also include guide paths to, from and between components that are all fixedly mounted to the machine. In the event of maintenance or repair, the machine must be taken out of service for the duration of that work. In addition, skilled technicians are generally required to tend to the machine during the entirety of the maintenance or repair procedure.

It has further been observed that the guides of known strappers, that is those portions of the strapper along which the strap material is guided while it is fed around the strap path tend to clog with debris from the strapping material. This debris can either be residue from the plastic strapping material itself, or debris that is carried by the strapping material into the machine. Typically, these guides have very small clearances between the guides themselves and between the guides and the active (driven or idle, rotating) machine components. As a result, it is necessary, at times, to shut down the machine, open the guide paths and clear these guide paths of debris. Known machines typically require disassembly of those portions of the machine which, again, requires significant labor and time. In addition, strappers are known to occasionally jam, in which strap material may get caught at about the active machine components or between the active and stationary machine components. In order to clear or remove these jams, again, the guide paths require disassembly necessitating time and labor.

Another concern with known strapping machines is that at times, the strap is not aligned with itself prior to forming the seal or "weld". In order to achieve maximum tension strength in the strap joint the strap should be fully aligned with an adjacent layer of strap prior to welding. This maximizes the area over which the weld is performed. Known strappers rely upon an alignment of stationary strap guides or paths in order to properly position the strap material in this aligned, adjacent arrangement. However, at times, the strap shifts as it is aligned or prior to welding, resulting in misaligned straps and less than optimal joint strength.

Accordingly, there exists a need for a strapping machine that utilizes modular components, specifically for the drive and sealing functions. Desirably, such modular components are readily removed and installed in machines to minimize the "down time" of such machines. Most desirably, such modular components are readily installed and removed, with minimal or no tools. Further, a need exists for a strapper that minimizes clogging and provides easy access to the guide areas. Again, most desirably, access is provided to these areas with minimal or no tools. Still more desirably, the guide pathway and covering therefor are formed as integral units further minimizing disassembly to clear these paths. In such a strapper, an auto re-feed arrangement is desirable without the use of separate feed and take-up wheels. A need further exist for a strapper in which strap alignment, prior to welding, is actively provided.

BRIEF SUMMARY OF THE INVENTION

A strapping machine positioning a strapping material around an associated load and seals the strapping material to itself around the load. The strapping machine includes a frame, a chute defining a strap path mounted to the frame, a modular feed assembly mounted to the frame, a guide mounted to the frame adjacent the feed assembly, and a modular strapping head mounted to the frame independent of the feed assembly and the guide.

The feed assembly is configured to feed the strapping material from a source to the guide. The guide is mounted to the frame independent of the feed assembly and the strapping head. The guide is configured to receive the strapping material from the feed assembly and to provide a path for the strapping material toward the strapping head.

The strapping head includes a body and provides a conveyance path for the strapping material to the chute. In one embodiment, the strapping head defines a first conveyance path for the strapping material from the guide to the chute, and a second conveyance path to receive a free end of the strapping material to seal the strapping material to itself.

Preferably, the strapping head includes an anvil movably mounted to the body and forming a part of the second conveyance path. The anvil is movable between a first conveying position in which the anvil is pivoted away from the body to enlarge the second conveyance path and a second sealing position in which the anvil is pivoted toward the body to narrow the second conveyance path.

The anvil can be pivotally movable toward and away from the body. Preferably, the anvil is biased toward the body. In this arrangement, strapping head includes a side plate pivotally mounted to the body. The anvil is fixedly mounted to the side plate. The strapping head can include a cam for moving the anvil between the first conveying position and the second sealing position. The cam cooperates with the side plate to pivot the anvil.

The present strapping machine further contemplates an embodiment in which a controller controls the operation of the strapping machine. The controller is operably connected to the feed assembly.

A sensor is disposed to sense the presence and absence of strapping material at the strapping head. The sensor includes first and second movable elements, preferably paddles, that cooperate with one another. The paddles are movable between a first position in which the sensor senses the presence of strapping material and a second position in which the sensor senses the absence of strapping material. The sensor is operably connected to the controller and when the sensor senses the absence of strapping material at the strapping head, a control signal is generated to initiate operation of the feed assembly in a refeed mode.

In a current embodiment, the sensor is mounted to the strapping head at about a strap exit path of the strapping material from the strapping head. Preferably, the paddles pivot about a common pivot pin. The strapping material engages the first paddle to pivot the paddles between the first and second positions.

The sensor can include a proximity sensor cooperating with the first and second paddles. The second paddle is positioned between the proximity sensor and the first paddle being. The first paddle is biased toward the proximity sensor and the second paddle is biased away from the first paddle. First and second biasing elements bias the first paddle toward the proximity sensor and the second paddle away from the first paddle, respectively.

A hinge stop limits travel of the first and second paddles away from one another. The second paddle operably contacts the proximity sensor during the feed mode and the take-up mode, and the second paddle is operably separated from the proximity sensor during a refeed mode.

A preferred strapping head includes a second conveyance path to receive a free end of the strapping material to seal the strapping material to itself. The second conveyance path is defined by a plurality of surfaces within the body. The surfaces define a substantially constant width path through the second conveyance path.

An entryway precedes the second conveyance path. The entryway has a larger path width than the conveyance path width. A gripper is disposed at a terminal end of the conveyance path.

The strapping machine further contemplates an easy access transfer guide mounted to the frame between the feed assembly and the strapping head. The transfer guide includes a fixed portion and a cover portion. The fixed portion is fixedly mounted to the frame independent of the feed assembly and the strapping head. The transfer guide is configured to receive the strapping material from the feed assembly and to provide a path for the strapping material toward the strapping head. The cover portion overlies the fixed portion along a plane that is substantially parallel to the a plane defined by a longitudinal axis and a width of the strapping material.

In a preferred arrangement, the cover portion is pivotally mounted to the fixed portion by hinges and is retained in place covering the fixed portion by at least one, and preferably multiple mechanical fasteners. Most preferably, the mechanical fasteners are knurled to permit tool-less loosening. In a current embodiment, fasteners include a hinge-supported portion, so that when the fasteners are loosened from the cover portion (e.g., pivoted away from the cover portion) the hinge-supported portions retain the fasteners mounted to the fixed portion.

The strapping machine can further include an easy access feed guide for covering at least a portion of the feed assembly. The feed guide includes a cover for covering at least a portion of the feed assembly and an arcuate guide wall transverse to the cover. The guide portion is generally parallel to the strapping material as is traverses through the guide. The guide wall is spaced from a periphery of one of the feed wheels at about an entry of the strapping material into the feed guide and converges toward a periphery of the one of the feed wheels as the guide wall approaches the nip of the feed wheels.

The cover portion is removably mounted to the fixed portion by mechanical fasteners. Preferably, the fasteners are knurled to permit tool-less loosening. Most preferably, hinge-supported fasteners are used to mount the cover to the feed guide. This permits the cover portion to be readily removed for quick cleaning.

These and other features and advantages of the present invention will be apparent from the following detailed description, in conjunction with the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

The benefits and advantages of the present invention will become more readily apparent to those of ordinary skill in the relevant art after reviewing the following detailed description and accompanying drawings, wherein:

FIG. **1** is a perspective view of an improved modular strapping machine in accordance with the principles of the present invention, the strapping machine being illustrated with the strapping head partially removed from the frame, and a portion of the frame missing at about the feeding assembly, for clarity of illustration;

FIG. **2** is a schematic illustration of the strapping machine function, illustrating the strap being fed around a load;

FIG. **3** is a partial perspective view of the modular strapping machine feed assembly and strapping head removed from the frame for clarity of illustration;

FIG. **4** is a partial perspective view of the feed assembly and the frame portion in which it is mounted;

FIG. **5** is a bottom view of the strapping head showing the anvil pivoted outwardly during the feed and retraction modes of operation;

FIG. **6** is a bottom view of the strapping head anvil showing the anvil pivoted inwardly as during the sealing (welding) operation of the strapping head;

FIG. **7** is a perspective view of a strap sensor embodying the principles of the present invention, the sensor being shown when in strapping machine is operating in the refeed mode;

FIG. **8** is a perspective view of the sensor when the strapping machine is operating in the retraction mode;

FIG. **9** is a perspective view of the sensor when the strapping machine is in the strapping mode;

FIG. **10** is an exploded view of the sensor;

FIG. **11** is a perspective view of the gripper and portions of the gripper path through the strapping head;

FIG. **12** is a side view of the gripper of FIG. **11**; and

FIG. **13** is an exploded view of the gripper of FIGS. **11** and **12**.

DETAILED DESCRIPTION OF THE INVENTION

While the present invention is susceptible of embodiment in various forms, there is shown in the drawings and will hereinafter be described a presently preferred embodiment with the understanding that the present disclosure is to be considered an exemplification of the invention and is not intended to limit the invention to the specific embodiment illustrated.

It should be further understood that the title of this section of this specification, namely, "Detailed Description Of The Invention", relates to a requirement of the United States Patent Office, and does not imply, nor should be inferred to limit the subject matter disclosed herein.

Referring to the figures and in particular, to FIG. **1**, there is shown a strapping machine or strapper **10** embodying the principles of the present invention. The strapper **10** includes a frame **12** having a work surface or top **14** mounted thereto. The frame **12** defines a chute or strap path **16** about which the strap S is conveyed during a strapping operation. A strap supply P provides the strap material S for the strapper **10**.

The strap S is fed from the supply P into the strapper **10** by a feed arrangement **18**. The strap S is conveyed by the feed arrangement **18**, through a strapping head **20** into the chute **16**. The strap material S traverses through the chute **16**, and returns to the strapping head **20**. The free end (that is the first fed end of the strap S) is, upon return to the strapping head **20**, gripped by a first gripping portion **22***a* of a gripper **22** in the strapping head **20**. The feed mechanism **18** then reverses to provide tension in the strap S. When a desired tension is achieved, the strap S is gripped by a second portion **22**b of the gripper **22**. The strap S is then cut to separate the strap S from the source P. The strap S is then welded or otherwise sealed onto itself. The load L is then removed from inside the chute **16** region or strap path and a new load is positioned therein for strapping.

Unlike known strappers, the present strapper **10** includes a modular arrangement in which the feed assembly **18** and strapping head **20** are removably mounted to the frame **12**. That is, the feed arrangement **18**, which includes generally a motor **24**, and a pair of feed wheels **26**, **28**, is mounted to a base **30** that is in turn mounted to the frame **12**. Referring to FIG. **3**, there is shown an exemplary feed assembly **18** illustrating the motor **24**, a driven wheel **26** and an idler wheel **28**. The idler wheel **28** is mounted for free rotation with the driven wheel **26** when the strap material S is between the driven wheel **26** and the idler wheel **28** and the motor **24** is actuated.

To assure that the feed assembly **18** is properly mounted within the frame **12**, the feed assembly **18** and frame **12** include portions of a cooperating aligning and mounting assembly **32**. In one such arrangement, as shown in FIGS. **1** and **4**, the frame **12** includes a **34** nesting member configured as a transverse beam element. The feed assembly **18** includes a complementary, cooperating receiving member **36** that aligns with the transverse beam **34**. In a current embodiment, the receiving member **36** is formed as a generally channel shaped aligning head **38** having a pair of slots or rounded notches **40** formed therein complementary to the beam **34**. The feed assembly **18** is positioned in the frame **12** such that the notches **40** are fitted onto the beam **34**. This aligns the feed assembly **18** in the frame **12**.

At a rear end **42** of the feed assembly **18**, the aligning and mounting assembly **32** includes a clamp **44**. The clamp **44** can be formed, for example, as a handle **46** that is mounted to a threaded stud **48**. The frame **12** can include a base portion **50** having a notch **52** formed therein. The notch **52** has an enlarged or V-shaped opening **54** to readily permit aligning the stud **48** in the notch **52**. As the feed assembly **18** is positioned on the frame **12**, the aligning notches **40** are positioned immediately forward of the beam **34** and the stud **48** is positioned in the open end **54** of the V-opening. The feed assembly **18** is then urged forward until the notches **40** are positioned on the beam **34** and the stud **48** is positioned in the base notch **52**. The handle **46** is then rotated to clamp the feed assembly **18** securely in place on the frame **12**. In this manner, a discharge area **56** of the feed assembly **18** (as illustrated in FIG. **3**) is properly aligned with a strap guide (the transfer guide **58**) or strap guide for transport of the strapping material S to the strapping head **20**.

The strapping head **20** is mounted to the frame **12** in a similar manner. To this end, the strapping head **20** and the frame **12** include portions of a cooperating aligning and clamping assembly **60**. The frame **12** includes an upper base or shelf **62** having a transverse, forward lip **64**. The lip **64** has an opening **66** therein for receiving the strapping head **20**. The opening **66** is formed by a pair of walls **68***a,b* having aligning slots or notches **70** formed therein.

The strapping head **20** includes an aligning or nesting member **72** that, when the head **20** is moved forwardly in the frame **12**, resides in the aligning slots **70**. In a present embodiment, the aligning member **72** is formed as a beam or like member, and the aligning slots **70** in the walls **68***a,b* receive the beam **72**. A rear end **74** of the shelf **62** includes a notched opening **76** having an enlarged or V-shaped entrance **78**. The strapping head **20** includes a clamp **80** such as the exemplary threaded stud **82**, and a handle **84** for threading the stud **82**. As with the feed assembly **18**, when the strapping head assembly **20** is urged forward, the beam **72** is urged into the slots **70** as the stud **82** is urged into the clamping notch **76**. Once the strapping head **20** is properly positioned, the handle **84** is rotated to clamp the strapping head **20** in place on the frame **12**.

The present arrangement has a number of advantages over known strappers. First, the modular, tool-less arrangement permits readily changing out either the strapping head **20** or the feed assembly **18**. As such, as maintenance or repair is required on either the strapping head **20** or the feed assembly **18**, that portion of the strapper **10** can be removed and a spare inserted in its place. In this manner, the operational "down-time" of the machine **10** is minimized. That is, the strapping head **20** or feed assembly **18** can be removed and a spare installed in, perhaps less than a minute. That portion of the strapper **10** requiring maintenance or repair (e.g., the feed assembly **18** or strapping head **20**) can then be removed and taken away, for example, to a maintenance shop, where the necessary work can be carried out, away from the strapping machine **10** and other operations.

Another advantage provided by the present strapper **10** is that it establishes a distance between the feed assembly **18** and the strapping head **20**. Those skilled in the art will recognized that, at times, strapping material becomes jammed or are misfed into the strapper **10**. When this occurs, it is most desirable to have a strapper **10** having an auto eject and re-feed arrangement. In such an arrangement, the misfed strap is automatically ejected from the strapper and the strap feed is automatically restarted to place the strapper **10** back into operation. Thus, operator time and attention is minimized by automatically ejecting the misfed strap and automatically refeeding from the strap supply. An exemplary auto refeed arrangement is illustrated in the aforementioned Bell, et al., U.S. Pat. No. 5,640,899.

One drawback to known auto refeed arrangements is that there must be a sufficient distance between the feed wheels and the strapping head to prevent the strap material from being ejected beyond the feed wheels (by the take-up or tension wheels). This is of particular concern in that the machines operate at relatively high speeds and the detecting instruments and control system have certain reaction time constraints. That is, because the strap is conveyed so quickly through the machine, after a misfeed is detected, the strap can be ejected from the machine by the take-up wheels beyond the feed wheels, thus defeating the auto-refeed function. In other words, if there is insufficient distance between the strapping head (which is the location of the misfeed detector) and the feed wheels, the take-up wheels will eject the strap beyond the feed wheels. As such, there will not be fresh strap material to be fed through the feed wheels to the strapping head.

The present arrangement provides the necessary distance between a strap misfeed detector **86** (mounted on the strapping head **20**) and the feed wheels **26**, **28**. As such, only a single set of wheels (e.g., the pair of wheels **26**, **28**) is required for both the feed and retraction functions. In this manner, when a misfeed is detected, the feed wheels reverse to eject the misfed strap from the strapping head **20**. When the jammed or misfed strap is cleared, there is sufficient distance between the detector **86** and the feed wheels **26**, **28** for the feed wheels **26**, **28** to be stopped (from the reverse direction) and returned to the forward feeding direction.

Referring now to FIGS. **3** and **7–10**, the strap detector **86** assembly cooperates with the feed assembly **18**, that is the feed wheels **26**, **28**, to stop forward movement of the strap material S when a misfeed is detected, reverse the wheels **26**, **28** to eject misfed strap, and subsequently reinitiate forward movement (refeed) of the strap material S after the misfed strap is ejected. The misfeed detector **86** is mounted at about the top **88** of the strapping head **20** and includes a proximity sensor **90** and first and second biased elements **92**, **94**, respectively. In a present embodiment, the biased elements **92**, **94** are first and second paddles that are biasedly mounted to a base **96** at a detecting end of the proximity sensor **90**. The paddles **92**, **94** are hingedly or pivotally mounted to the base **96** by a common pivot pin **98**.

The paddles **92**, **94** are mounted such that the second paddle **94** is positioned between the first paddle **92** and the base **96**. A biasing element **100**, such the exemplary first spring biases the first paddle **92** away from the base **96** and the proximity sensor **90**. A second biasing element **102**, such as the exemplary second spring biases the second paddle **94** away from the first paddle **92**. In this manner, in order to maintain the second paddle **94** in contact with the proximity sensor **90**, a force must be exerted on the paddles **92**, **94** against the force of the first spring **100**.

The paddles **92**, **94** are positioned to lie across the strap path as indicated at **104**, e.g., on the top of the strapping head path, when there is no force exerted against the first spring **100**. Conversely, when a strap S is in the strap path **104**, and the paddles **92**, **94** are in the feed position (as seen in FIG. **9**), first paddle **92** is urged against its spring **100** force, toward the proximity sensor **90**. The second paddle **94** is operably connected to the first paddle **92** such that any force exerted on the first paddle **92** urges the second paddle **94** into contact with the proximity sensor **90**. Although the second paddle **94** is biased away from the first paddle **92**, the spring force of the first spring **100** is greater than the spring force of the second spring **102**. As such, the first paddle **92** forces the second paddle **94**, against the spring force of the second spring **102**, into contact with the proximity sensor **90**.

In the take-up position, as illustrated in FIG. **8**, there is sufficient slack (or lack of tension) in the strap S to permit the first paddle **92** to "drop". However, because some tension remains in the strap S, the first paddle **92** does not "drop" fully to rest on the top **88** of the strapping head **20**. Thus, even though the first paddle **92** has moved down (but not fully dropped) the spring force of the second spring **102** maintains the second paddle **94** in contact with the proximity sensor **90**.

Referring now to FIG. **7**, the paddles **92**, **94** are shown in the refeed position, in which the strap S is fully full missing from the strapping head path **104**. In this position, the first paddle **92** fully "drops" to rest on the top **88** of the strapping head **20**, as urged by the force of the first spring **100**. Even though the force of the second spring **102** urges the second paddle **94** away from the first paddle **92** (upward, toward the proximity sensor **90**), a hinge stop **106** on the first paddle **92** at the hinge region **108** (best seen in FIG. **10**) contacts a flat **110** on the second paddle **94** at the hinge region **108**, thus preventing further separation of the paddles **92**, **94** from one another. In this arrangement, contact of the hinge stop **106** with the flat **110** prevents the paddles **92**, **94** from separating from one another beyond an angle of about 45°. In this manner, when the strap S is fully missing from the strapping head path **104**, because the spring force of the first spring **100** is greater than the spring force of the second spring **102**, and due to the engagement of the hinge stop **106** with the flat **110**, the second paddle **94** is pulled from contact with the proximity sensor **90**. This initiates a refeed sequence in the strapping machine controller **112**.

This dual paddle **92**, **94** arrangement provides for continued contact of the second paddle **94** with the proximity sensor **90** when the strapper **10** is in the feed mode, and the take-up or retraction mode. As will be recognized by those skilled in the art, when there is a reduced tension on the strap material S, the first paddle **92** may move away from the second paddle **94**, however, it will not move so far as to permit the second paddle **94** to disengage from or lose contact with the proximity sensor **90**. Also as will be recognized by those skilled in the art, when there is a misfeed of strap S, when the seal or weld fails, or when the strap S breaks, the first paddle **92** will move fully away from the proximity sensor **90**, allowing the second paddle **94** to break contact with the sensor **90**.

When the detector **86** detects a misfed strap S (i.e., when the second paddle **94** breaks contact with the sensor **90**), the strapper S may be controlled such that the strapper **10** automatically operates in an ejection mode, in which any strap S remaining within the strapping head **20** is ejected therefrom. Following ejection, the auto refeed sequence can start in which strap material S is automatically refed by the feed wheels **26, 28** up to the strapping head **20**. Detector arrangements other than that illustrated will be recognized by those skilled in the art and are within the scope of the present invention.

Referring now to FIG. **3**, the present strapper **10** includes multiple easy access guides **58, 114**. As their references suggest, these guides **58, 114** provide ready access to the strap path in order to, for example, clean debris and/or clogs from the path. Unlike known strappers, the guides **58, 114** are formed as part of removable sections of the strapper **10**. That is, while in known strappers, doors provide access to a fixed guide, the present guides **58, 114** are formed as part of the removable portions of the machine **10**. As seen in FIG. **3**, a feed guide **114** is formed as part of the removable section covering the feed wheels **26, 28**.

The feed guide **114** includes a curved or arcuate guide portion **116** (shown in phantom lines) that extends from an entryway **118** below the feed wheel motor or drive **24** to about a nip **120** of the wheels **26, 28**. At the entryway **118**, the guide portion **116** is spaced from a periphery of the driven wheel **26**. Traversing along the arc of the guide **114** toward the nip **120**, the guide portion **116** approaches the periphery of the driven wheel **26**. Referring to FIG. **3**, it can be seen that the strapping material S enters the feed guide **114**, traversing below the feed drive **24**. The strapping material S is guided by the guide portion **116** into the nip **120** for feeding to the strapping head **120**.

In a current embodiment, the guide **114** is retained in place on the feed assembly **20** (covering at least a portion of the feed wheels **26, 28**) by a plurality of threaded fasteners **122**, illustrative of which are the three fasteners shown. The fasteners **122** are preferably knurled to permit installation and removal without the use of tools, e.g., by hand. The fasteners **122** can be supported on hinged or pivoting supports **124** that, once loosened, permit pivoting the fasteners **122** away from the guide **114** to permit removal. In this manner, the fasteners **122** are maintained affixed to the feed assembly **18**, thus preventing inadvertently misplacing the fasteners **122**.

As will be appreciated from the figures, because the guide **114** itself includes that surface **116** on which the strapping material S travels during operation, the guide **114** can be readily removed from the feed assembly **18**, and the surface **116** cleaned of debris. The guide **114** can then be readily replaced on the feed assembly **18**. Again, this is unlike known guides which are fixed in place and are only accessible by pivoting door or access panel. In that, as set forth above, the tolerances are rather small and the spaces rather narrow through the strap path, the present easy access feed guide **114** provides numerous, readily appreciated advantages over the prior known guide access arrangements.

A bridging or transfer easy access guide **58** extends, as set forth above, between the feed assembly **18** and the strapping head **20**. In that this portion of the feed path extends between the two modular components, it is fixedly mounted to the frame **12**. However, this guide **58** is positioned in a region of the strapping machine **10** that is readily accessible even with the feed assembly **18** in place. In this manner, the path itself is readily accessibly to perform maintenance or, for example, to dislodge debris or jammed strap material S.

Additionally, the guide **58** is configured so that it is easily opened or uncovered to permit ready access to the strap path. The guide **58** includes, as provided above, a fixed portion **126** that extends between the feed assembly **18** discharge and the entrance of the strapping head **20**. A cover **128** is mounted to the fixed guide portion **126** that covers the fixed pathway **126**. Preferably, the cover **128** is hingedly mounted to the fixed portion **126**, by hinges **129** (one shown) so that it is readily pivoted open. In a preferred arrangement, mechanical fasteners **130**, such as the hinge-supported fasteners used for the feed guide **114**, are disposed on the fixed portion **126**, to maintain the cover **128** in place. Thus, to remove the cover **128**, it is necessary only to loosen the fasteners **130** (by hand, without the need for tools) and pivot them out of the way. The cover **128** can then be pivoted from the fixed path portion **126** (again, by hand, without the need for tools) to provide access thereto.

Also unlike known strapper path access doors, the present transfer guide cover **128** permits access to the strap across the width of the strap S. Conventional strapping machines include access doors that open to permit access to the strapping material at the thickness (i.e., the gauge measurement dimension) of the strap. Thus, grasping the strap can be a difficult and arduous task. As will be appreciated by those skilled in the art, providing access to the strap S at the width dimension provides a larger area in which to work and greatly facilitates access to debris or pieces of strap material S that may be lodged in the strap path **126**.

Referring now to FIGS. **5–6**, the present strapper includes a novel strapping head assembly **20** that utilizes a moving anvil **132**. As will be recognized by those skilled in the art, the anvil **132** is that portion of the strapping head **20** against which the strapping material S is pressed during the sealing or welding operation. In order to increase the speed and efficiency of the operation of strappers generally, the strap path at this point is generally narrow and is typically sized only slightly larger than the strap S itself. To this end, known strapping machines include a constriction or throat at about the entrance to the at which debris can collect. Over time, the collection of debris at this area constricts the entrance to the anvil generally resulting in increased strap misfeeds and eventual maintenance of the machines.

The present strapper **10** includes a number of improvements that are directed to minimizing or eliminating this debris collection problem and minimal strap path size problem. Referring to FIGS. **5–6**, there is shown a bottom view of the strapping head **20**. The head **20** includes two openings for receiving strap S. The first course of strap enters the strapping head **20** through a first opening indicated generally at **134**. As the strap S is conveyed through this opening **134**, it passes beyond the anvil **132**. That is, it traverses through that portion of the head **20** that forms the anvil **132**.

The strap S then traverses beyond the head **20**, through the chute **16** and around the load L. The strap S is then directed into second opening indicated generally at **136**. Once the strap S enters the second opening **136**, it is grasped at the free end by the gripper **22** and tension is provided by the take-up operation of the feed assembly **18**.

The anvil **132** is mounted to the strapping head **20** in a pivoting arrangement. That is, when the strap material S is fed through the strapping head **20**, the anvil **132** pivots outwardly, away from the strap path to enlarge the size of the opening **136** through which the strap material S traverses. In this manner, an increased area is provided for the material S to move through the strapping head **20**. Specifically, the width dimension w of the path is increased, as is, consequently, the height h dimension. Once the material traverses through the chute **16** and back up through the gripper opening **136**, the anvil **132** then pivots back into place. A guide edge **137** of the anvil **132** urges the strap material S into place (to overlie the prior course of strap S) and the strap S is sealed to itself.

This novel pivoting anvil **132** arrangement provides a number of advantages over fixed anvils. First, as set forth above, it increases the area of the opening **136** through which the strap material S traverses, thus, reducing the possibility for misfeeds. Second, the pivoting anvil **132** moves the strap material S into position so that the first and second courses of strap materials overlie one another for sealing or welding. This increases the assurance that the first and second courses of strap material S will overlie one another without misalignment, to provide optimum strap seal strength.

In a current embodiment, the anvil **132** is fixedly mounted to a side plate **138** of the strapping head **20**. The side plate **138** is pivotally mounted to the strapping head body **140** by a pivoting arrangement, such as the exemplary pivot pin **142**. The plate **138** is biased toward the body **140**. A cam **144** is positioned within the strapping head body **140** and cooperates with the side plate **138**. During the feed cycle, the cam **144** rotates and a lobe **146** on the cam contacts the side plate **138**, urging the side plate **138** away from the body **140**. This, in turn, pivots the anvil **132** away from the body **140**, thus enlarging the opening **136**. During the gripping, take-up and sealing (e.g., welding) cycles, the cam shaft **144** further rotates such that the lobe **146** disengages from the side plate **138**, thus, allowing the anvil **132** to pivot back into place. Those skilled in the art will recognized other arrangements by which the pivoting anvil **132** can be provided, which other arrangements are within the scope and spirit of the present invention.

In addition to the pivoting anvil **132**, as best seen in FIGS. **11–13**, the present strapping head **20** includes a novel gripper path indicated generally at **148**, through which the first course of material traverses for gripping, prior to tensioning and sealing. Unlike known strappers in which the path tapers downwardly toward the gripper, in the present strapper **10**, the strap path **148** is formed from parallel walls **150**, **152** that provide a constant path width through the path **148** toward the gripper **22**. Although conventional design teaches away from such a constant cross-sectional path, it has been found that the benefits achieved by this path **148** configuration, that is less opportunity for debris collection and malfunction, far outweigh any of the disadvantages.

In the present disclosure, the words "a" or "an" are to be taken to include both the singular and the plural. Conversely, any reference to plural items shall, where appropriate, include the singular.

From the foregoing it will be observed that numerous modifications and variations can be effectuated without departing from the true spirit and scope of the novel concepts of the present invention. It is to be understood that no limitation with respect to the specific embodiments illustrated is intended or should be inferred. The disclosure is intended to cover by the appended claims all such modifications as fall within the scope of the claims.

What is claimed is:

1. A strapping machine for positioning a strapping material around an associated load and sealing the strapping material to itself around the load, the strapping machine comprising:

a frame;

a chute defining a strap path, the chute being mounted to the frame;

a feed assembly mounted to the frame, the feed assembly configured to operate in a feed mode to feed the strapping material and to operate in a take-up mode to retract the strapping material;

a strapping head configured to seal the strapping material to itself;

a controller for controlling the operation of the strapping machine, the controller being operably connected to the feed assembly; and

a sensor disposed to sense the presence and absence of strapping material at the strapping head, the sensor including first and second movable biased elements cooperating with one another, the movable biased elements being movable between a first position in which the sensor senses the presence of strapping material and a second position in which the sensor senses the absence of strapping material, the sensor being operably connected to the controller, wherein when the sensor senses the absence of strapping material at the strapping head, a control signal is generated to initiate operation of the feed assembly in a refeed mode.

2. The strapping machine in accordance with claim **1** wherein the sensor is mounted to the strapping head at about a strap exit path of the strapping material from the strapping head.

3. The strapping machine in accordance with claim **1** wherein the movable biased elements are configured as first and second pivoting paddles and wherein the strapping material engages the first paddle to pivot the paddles between the first and second positions.

4. The strapping machine in accordance with claim **3** including a proximity sensor cooperating with the first and second paddles, the second paddle being proximal to the proximity sensor and the first paddle being proximal to the second paddle, wherein the first paddle is biased away from the proximity sensor and the second paddle is biased away from the first paddle.

5. The strapping machine in accordance with claim **4** including first and second springs, wherein the first spring biases the first paddle away from the proximity sensor and the second spring biases the second paddle away from the first paddle.

6. The strapping machine in accordance with claim **5** including a hinge stop to limit travel of the first and second paddles away from one another.

7. The strapping machine in accordance with claim **4** wherein the second paddle operably contacts the proximity sensor during the feed mode and the take-up mode, and wherein the second paddle is operably separated from the proximity sensor during a refeed mode.

8. A strap sensor for use in a strapping machine of the type for positioning a strapping material around an associated load and sealing the strapping material to itself around the load, the strapping machine including a frame, a chute, a feed assembly configured to operate in a feed mode to feed the strapping material and to operate in a take-up mode to retract the strapping material, a controller for controlling the operation of the strapping machine operably connected to the feed assembly and a strapping head for sealing the strapping material to itself, the sensor comprising:

first and second movable biased elements cooperating with one another, and movable between a first position in which the sensor senses the presence of strapping material at the strapping head and a second position in which the sensor senses the absence of strapping material at the strapping head, the sensor being operably connected to the controller, wherein when the sensor senses the absence of strapping material at the strapping head, a control signal is generated to initiate operation of the feed assembly in a refeed mode.

9. The strap sensor in accordance with claim **8** wherein the sensor is configured to detect the presence or absence of strapping material at the strapping head, at about a strap exit path of the strapping material from the strapping head.

10. The strap sensor in accordance with claim **8** wherein the movable biased elements are configured as first and second pivoting paddles and wherein the strapping material engages the first paddle to pivot the paddles between the first and second positions.

11. The strap sensor in accordance with claim **10** including a proximity sensor cooperating with the first and second paddles, the second paddle being proximal to the proximity sensor and the first paddle being proximal to the second paddle, wherein the first paddle is biased away from the proximity sensor and the second paddle is biased away from the first paddle.

12. The strap sensor in accordance with claim **11** including first and second springs, wherein the first spring biases the first paddle away from the proximity sensor and the second spring biases the second paddle away from the first paddle.

13. The strap sensor in accordance with claim **12** including a hinge stop to limit travel of the first and second paddles away from one another.

14. The strap sensor in accordance with claim **13** wherein the second paddle operably contacts the proximity sensor during the feed mode and the take-up mode, and wherein the second paddle is operably separated from the proximity sensor during a refeed mode.

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